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From Forest Nursery Notes Winter 2013

**39. © A molecular and fitness evaluation of commercially available versus locally collected blue lupine *Lupinus perennis* L. seeds for use in ecosystem restoration efforts.** Gibbs, J. P., Smart, L. B., Newhouse, A. E., and Leopold, D. J. Restoration Ecology online. 2012.

RESEARCH ARTICLE

# A Molecular and Fitness Evaluation of Commercially Available versus Locally Collected Blue Lupine *Lupinus perennis* L. Seeds for Use in Ecosystem Restoration Efforts

James P. Gibbs,<sup>1,2</sup> Lawrence B. Smart,<sup>1,3</sup> Andrew E. Newhouse,<sup>1</sup> and Donald J. Leopold<sup>1</sup>

## Abstract

Dependence on wild seed sources is often impractical for large-scale habitat restoration programs. Reliance on commercial seed supplies of unknown provenance and fitness is thereby warranted. Little consideration has been given, however, to how the large volumes of seed required should be sourced. We evaluated commercial and locally collected seed sources for potential use in a New York State-based, landscape-scale program for restoring blue lupine *Lupinus perennis*. Through analysis of microsatellite markers we determined that “native” lupine designations by some commercial suppliers were in fact interspecific hybrids and therefore unreliable; at least two commercial sources, however, were genetically as close to native New York populations as native New York populations were to one other.

Common garden experiments revealed that seed source influenced first-year overwintering survival and subsequent height growth of surviving plants; seed sources more closely related genetically to native New York populations survived better and produced more stems per individual in the field in the area targeted for restoration. We conclude that (1) commercial suppliers often but not always offer reliably characterized seed sources of sufficient genetic similarity to native populations to warrant their use in restoration projects and (2) genetic affinity of potential seed stock to native populations is positively related to its fitness in the environment targeted for restoration.

**Key words:** blue lupine, genetics, habitat restoration, Karner blue butterfly, *Lupinus perennis*, *Lycaeides melissa samuelis*, microsatellite, seed source.

## Introduction

Restoring historical ecosystem function to degraded sites—the primary goal of restoration ecology—requires recreating resilient plant and animal communities comprised of interacting, self-sustaining populations (Society for Ecological Restoration International Science and Policy Working Group 2004). The need to preferentially use species indigenous to a site targeted for restoration is well recognized (Millar and Libby 1989), but less resolved are genetic considerations at the species level. “Local” seed is typically recommended on the assumption that it will limit “pollution” of local gene pools and reduce incidence of outbreeding depression (Hufford & Mazer 2003; Potts et al. 2003) while experiencing better survival and growth (Mortlock 2000). There have been remarkably few assessments, however, of the performance of seeds

of different provenance in restoration efforts. When a specific plant–animal interaction is the focus of restoration, genetic issues become particularly significant, given the recent findings of strong contingencies between plant genetic diversity and arthropod diversity (Crutsinger et al. 2006). From a strictly practical perspective, commercial seed suppliers must typically be relied upon to provide seed in the volumes required for large-scale restoration projects (Mortlock 2000), yet little consideration has also been given to the assumption that characterizations of seed provenance made by commercial suppliers are reliable; fitness and policy consequences of using seed not “sold as advertised” are potentially dire.

Blue lupine is the primary host of the endangered Karner blue butterfly (*Lycaeides melissa samuelis* Nabokov) whose recovery is the primary motivation for large-scale restoration of sand plains ecosystems using blue lupine. Blue lupine decline is regarded as the main cause for the decline of Karner blue butterfly. Remnant populations of Karner blue butterfly occur in Minnesota, Wisconsin, Indiana, Michigan, and New Hampshire (Gompert et al. 2006). Former populations in Ohio, Massachusetts, Pennsylvania, and Ontario have apparently been extirpated (Savignano 1994).

Blue lupine was historically found primarily in pine/oak barrens and other open, sandy habitats with nutrient-poor soil

<sup>1</sup> Department of Environmental and Forest Biology, State University of New York College of Environmental Science and Forestry, 1 Forestry Drive, Syracuse, NY 13210, U.S.A.

<sup>2</sup> Address correspondence to J. P. Gibbs, email jpgibbs@esf.edu

<sup>3</sup> Present address: Department of Horticulture, Cornell University, New York State Agricultural Experiment Station, Geneva, NY 14456, U.S.A.